Volume 34 October. 1948 *Number 10*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

RUST PREVENTION
OF EQUIPMENT IN
STORAGE AND USE

PUBLISHED BY
THE TEXAS COMPANY
TEXACO PETROLEUM PRODUCTS

THE simple, inexpensive way to protect the exposed surfaces of your idle machinery, equipment and erected steel work from rust is to brush it with *Texaco Rustproof Compound L* or spray it with *Texaco Rustproof Compound (Spray)*. These highly effective products not only guard against rust but, if rust has already started, they penetrate it, arrest further rusting, make the existing rust easier to remove.

Texaco Rustproof Compounds form a *waterproof* film, soft and self-healing against accidental scratches. They go on easily and quickly . . . and are easy to remove when your machines go back into service. They are one of the most economical ways of fighting rust.

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TEXACO REG T.M.

TEXACO RUSTPROOF COMPOUND

LUBRICATION

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Vol. XXXIV October, 1948 No. 10

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Rust Prevention of Equipment in Storage and Use

ANY EQUIPMENT manufactured from iron or steel is confronted, starting with the moment of fabrication, with a battle against the destructive effects of wear when in use and corrosion when idle. Wear can be minimized by proper lubrication of all moving parts but corrosion must be guarded against not only while equipment is in use but especially when it is either temporarily idle or in storage.

The principal element of most machinery and equipment is iron. Iron does not occur in nature as the metal but combined with other elements, largely as an oxide. When iron oxide, or ore, is reduced in the blast furnace the free metal is obtained, which is further improved by the addition of small amounts of other elements to give the toughness and hardness required in steels for various machines of industry. The forces of nature, however, water plus oxygen in the air combine in a ceaseless effort to return metallic iron to iron oxide thus tending to revert the useful metal to a relatively useless form. It is as though nature rebels at man's success in making useful steel from ore by tearing down what man builds. Indeed nature will return all iron and steel articles to the oxides unless constant vigilance and protection is afforded.

In order to maintain our machines in satisfactory operating condition, the slightest corrosion or appearance of rust (iron oxide) must be prevented from forming on the working surfaces. Modern machined parts such as shafting, cylinders, ball and roller bearings, etc. are finished to extreme accuracy and smoothness. The development of rust on these surfaces can easily destroy the value of these machines merely by changing the precise dimensions or by roughening a smooth polished working surface.

Rust can occur just as easily on the exterior of equipment if not protected. It is not as destructive, however, to the performance of the machine as interior rusting and can be prevented relatively easily by the use of heavy rust preventive compounds or paint. The prevention of rust on the interior and working surfaces of machines is not only more important but frequently more difficult to accomplish.

The importance of rust prevention in equipment was fully realized during the past war and a great deal of progress was made on the improvement of materials and procedures to accomplish this regardless of the climatic conditions of operation or storage of military equipment. The lessons learned are being applied with success to the many peace time uses and storage of machines and equipment of all kinds.

Most machinery can be well protected against rust while in motion with ordinary lubricating oils or greases. Some equipment, however, is operated under conditions so severe that special lubricants are required to prevent rusting in the presence of air and moisture. Such cases are the steam turbine, hydraulic equipment, paper machines, pneumatic tools, etc. All equipment in storage is exposed to rusting influences unless either packaged to keep

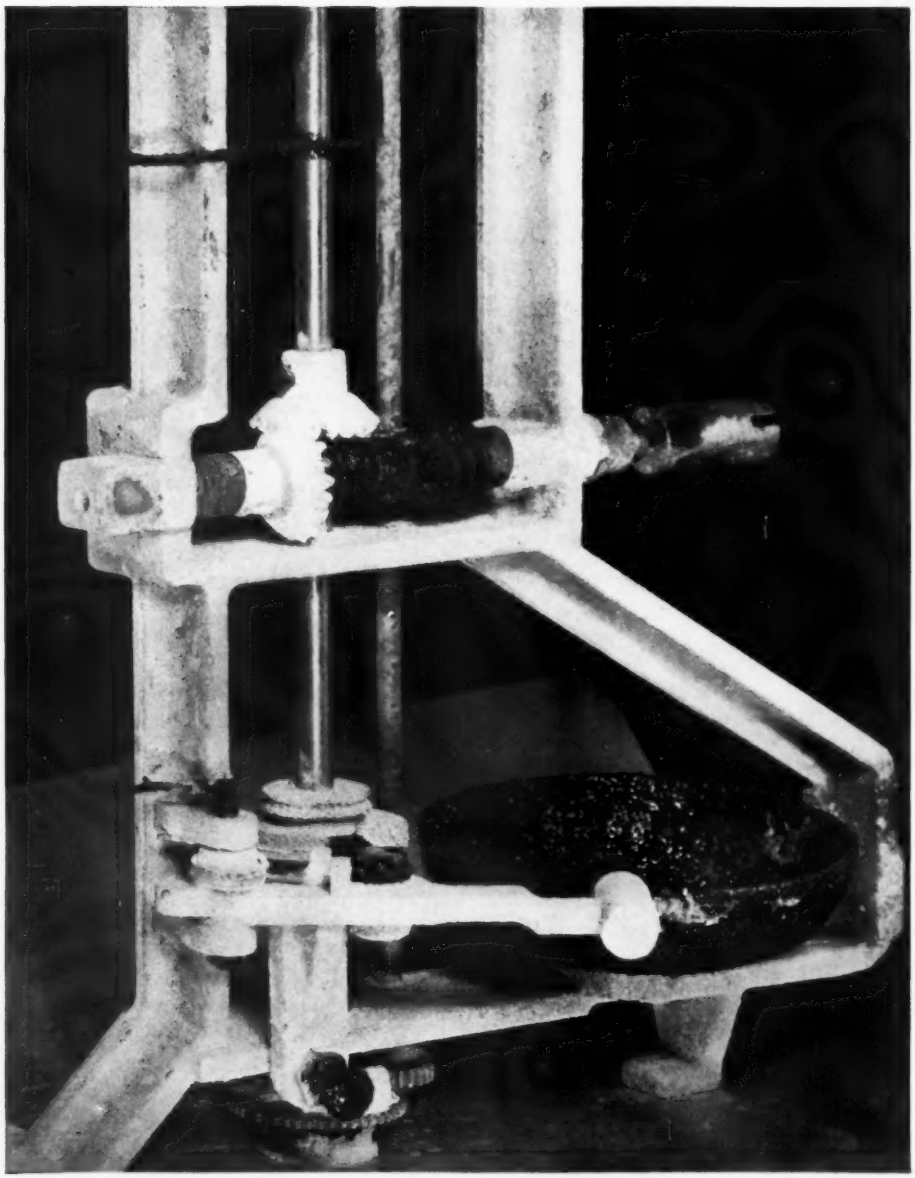


Figure 1 — A Mechanical Assembly received in the Far East rusted beyond use due 'o lack of rust protector when packaged.

out moist air or protected with lubricants designed to prevent rusting in the presence of moisture and air.

THE PRODUCTS AVAILABLE

Inhibited oils have been developed which contain small amounts of chemicals which increase the protection against both oxygen and moisture in the air and liquids containing corrosive chemicals such as the by-products of combustion from an engine. Special oils are available which prevent rusting in turbines and hydraulic systems. Greases are now manufactured which will protect against corrosion which otherwise would occur with ordinary greases when equipment is allowed to remain idle. Special rust preventive compounds will protect surfaces against severe corrosive conditions and should always be used if equipment is to be in storage a long time. They can be removed by washing with petroleum solvents such as kerosine when the equipment is placed in service.

Figure 2 — Showing a badly rusted float control valve spool from a hydraulic system due to water in hydraulic oil which did not contain a rust inhibitor.

RUST PREVENTIVE MATERIALS

Oils

A number of types of oils are manufactured having rust preventive characteristics designed for specific purposes. These can be generally classified as follows:

1. Oils intended for rust prevention of parts during manufacture and in packaged storage.
2. Oils intended for use in internal combustion engines just prior to shipping or placing in storage.
3. Oils intended for lubrication in the presence of air and moisture such as in turbine and hydraulic systems.

Compounds

Petroleum base compounds of the viscous type give more sustained protection than oils against rusting of idle machinery and structures either under cover or exposed to the weather. They have sufficient body so that thick films can be maintained and still can be removed with a solvent when necessary. They are manufactured in natural and black colors in various consistencies as required for different methods of application. They are not suitable for use as lubricants but do not dry out hard.

Greases

Many grades and types of greases are now manufactured which have rust preventive properties not possessed by ordinary grease. The selection of a grease having the best rust inhibiting characteristics for a given purpose should be based primarily upon the lubrication requirements.

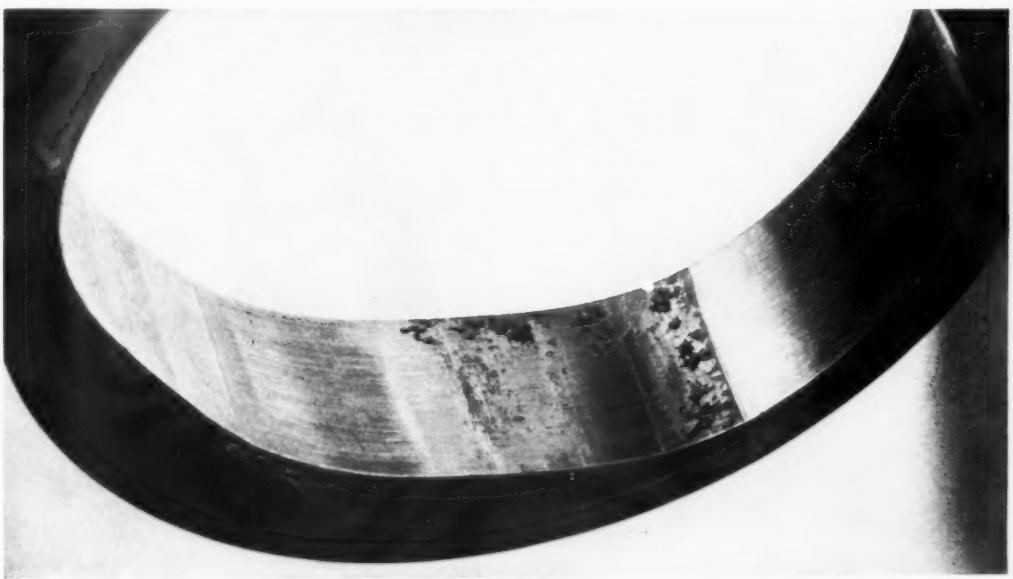
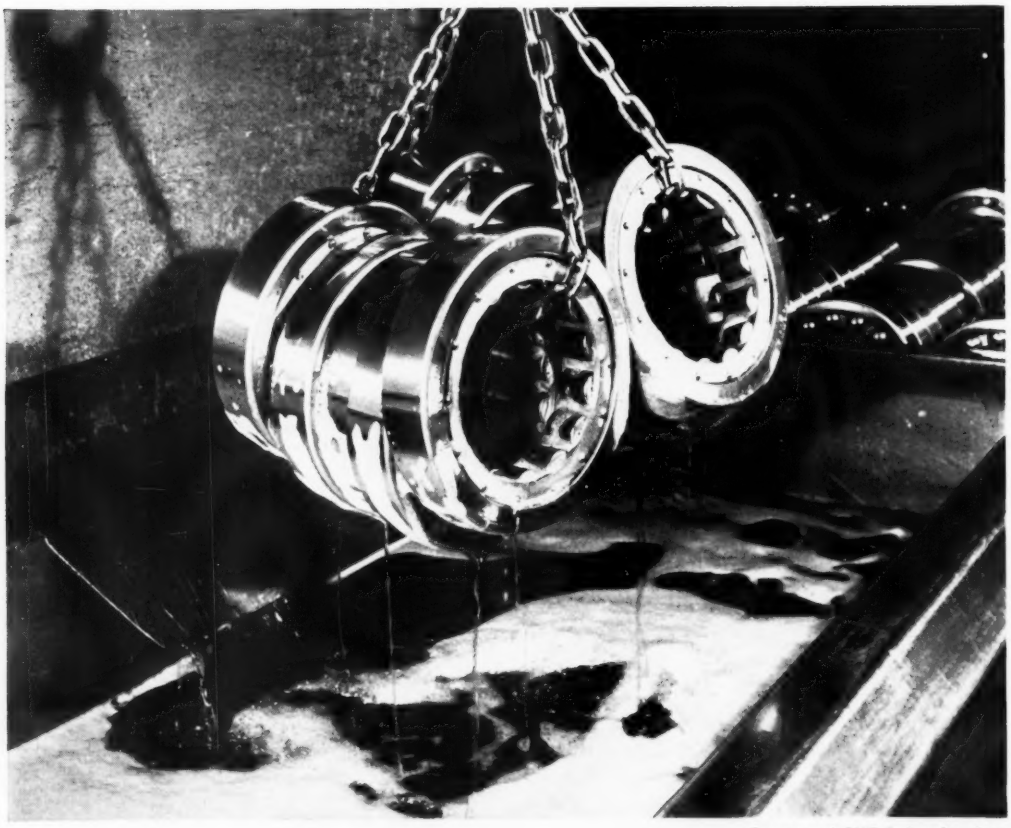


Figure 3 — Showing how a ring from a rotary-vane pump can become rusted when hydraulic oil is not suitably fortified to act as a rust-preventive in the presence of moisture.



Courtesy of SKF Industries, Inc.

Figure 4 — Dipping large traction motor bearings in hot rust preventive compound.

PROCEDURES FOR PRESERVING EQUIPMENT

Procedures recommended for the protection of various equipment which are suitable either for use on new equipment prior to placing in service or on used equipment which is to be idle, are as follows:

Engines

Working surfaces such as cylinders of internal combustion engines may become sufficiently rusty as to be non-operable if not properly protected during idle periods. A good grade of preservative oil should always be used in such equipment when it is known that it is not going to be placed in service in the immediate future. Good practice in protecting such engines from damage is as follows:

1. Drain used oil from crankcase while engine is still hot after running and flush with a light flushing oil. Be sure that a clean oil filter cartridge is installed. Refill crankcase with the proper preservative oil, run engine at fast idle for 15 to 20 minutes and shut down. The use of 3% of preservative oil mixed with the fuel for diesel engines during this run will assist in preventing corrosion of the injectors.

2. Remove spark plugs and spray preservative oil into each cylinder through spark plug hole while engine is being turned over slowly by hand. Dip electrodes and threads of spark plug in preservative oil and replace.

If equipment is available this procedure may be replaced by injecting preservative oil into the intake manifold during the shut-down run. This method is preferred for aircraft engines.

3. Remove distributor cap and coat each lobe of breaker cam with a film of rust preventive compound. Replace cap and seal breather hole in cap with waterproof tape.

4. On valve in head engines remove valve cover and spray preservative oil over rocker arm mechanism, interior of valve cover and between cylinder block and side plate over push rods. Replace cover.

5. On gasoline engines drain fuel system including carburetor, fuel pump strainer, lines and tank. Close all openings and re-connect all fittings. Apply rust preventive compound to all linkage, pins, choke and throttle rods.

6. Be careful not to get oil or grease on rubber connections or parts as serious deterioration may result.

7. When placing engines in service after storage all rust preventive compound should be removed with kerosine. Then, the crankcase should be drained, flushed and filled with the proper lubricating oil for operating.

Oils intended primarily for preservation of engines in storage should only be used as lubricating oils for short periods of operation since they are usually not designed for continuous duty as lubricants. Some heavy duty motor oils have quite good rust protective properties and should be used in engines subject to intermittent idle periods such as those in life boats, standby engines in plants, etc.

Ball and Roller Bearings

There is probably no class of machined steel units that are more vital to all types of modern equipment than the ball or roller bearing. They are used in innumerable machines and are frequently idle for periods between manufacture and installation and use. Spare bearings are usually stocked for replacement purposes and are therefore subject to variable periods of storage up to several years before being used. They, therefore, require particular attention and care in order to protect them from corrosion.

Ball and roller bearings which are lubricated at the factory and provided with seals are intended to be installed ready to operate and should not require re-lubrication during use. The selection of lubricant for such a bearing is, therefore, of utmost importance. A grease having the desired rust inhibiting characteristics and which is as resistant as possible to oxidation in either storage or service should be used. The bearings should be carefully cleaned free from all shop coating, dirt, metal chips and perspiration. After cleaning they should be handled only with clean cotton gloves or tongs to avoid later corrosion at points in contact with perspiration.

Bearings that are not pre-lubricated should be thoroughly protected with a rust preventive oil or light non-hardening compound. It appears preferable to select this material of such consistency that free turning of the bearing is permitted. Although it might be considered desirable to remove the rust preventive material before placing bearings in service and thereby avoid contamination of the lubricant with the rust preventive, it is considered preferable not to do this due to the possibility of permitting dirt to enter the bearing during this procedure. Most bearing manufacturers, therefore, recommend to install the bearing directly from the package and lubricate. Rust preventives used for bearings should be selected so that they either are readily displaced by the lubricant when placed in service or do not detract from the proper functioning of the lubricant when allowed to remain in the bearing and become mixed with the lubricant.

Courtesy of Norton Company

Figure 5 — An automatic cam grinding machine receiving fluid application of rustproof compound before crating and shipping.

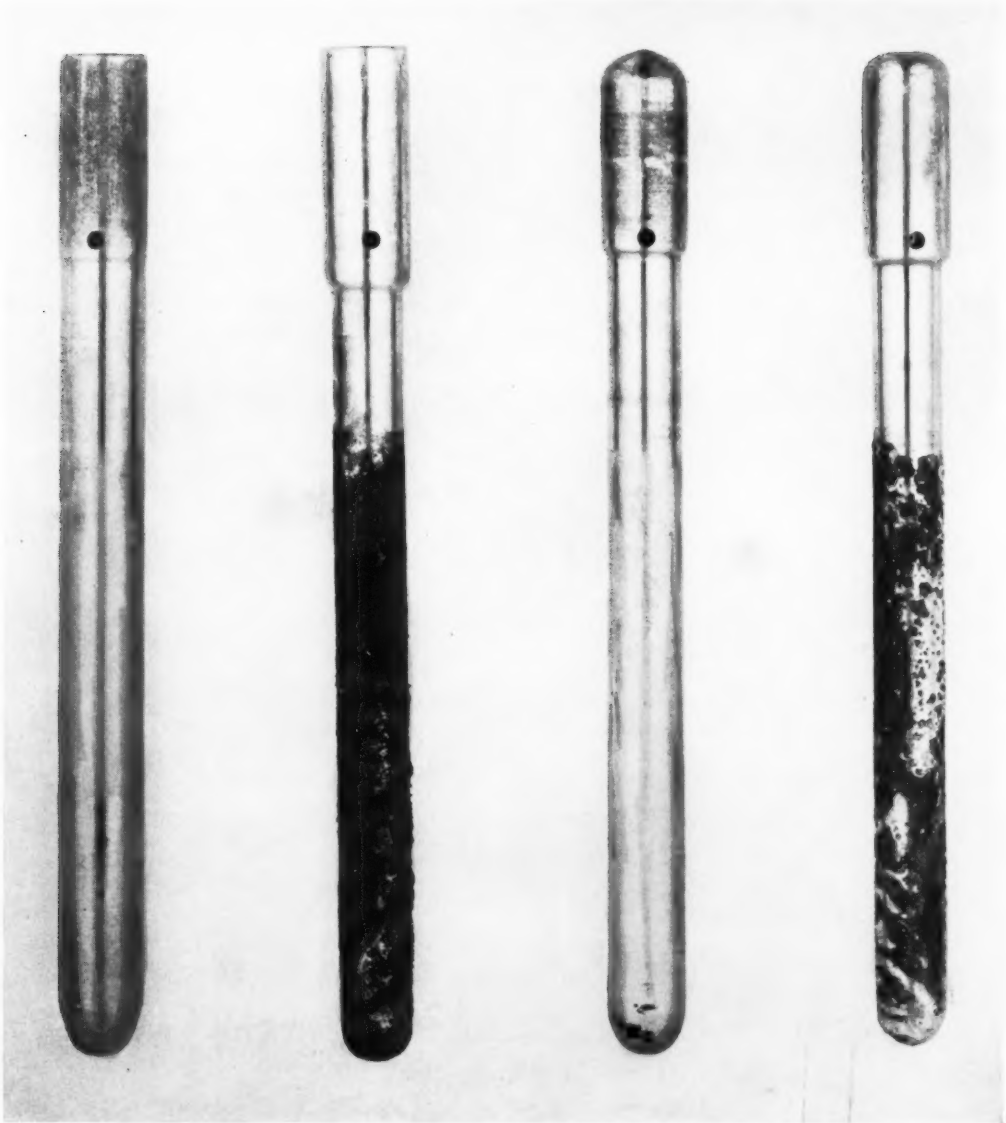


Figure 6 — Test rods after turbine oil rusting test — ASTM D-665-47T.

A — Rust inhibited turbine oil run with distilled water.
B — Uninhibited turbine oil run with distilled water.
C — Oil A run with salt water.
D — Oil B run with salt water.

Turbines

The continuous satisfactory operation of a well designed turbine unit depends very largely on proper function of the lubricating system. The most important single requirement for satisfactory lubrication is that the system be clean and free from rust and dirt. Careful preparation of the entire system is, therefore, essential.

All piping should be thoroughly cleaned before shipment, by immersion in hot alkaline solution. It should then be washed and pickled in hot dilute hydrochloric or sulfuric acid to which an inhibitor has been added to prevent attack on the metal. It should then be washed with clean water, dried and immediately coated with a rust preventive compound which can readily be removed with a light petroleum flushing oil after installation.

Cast and fabricated parts such as bearing pedestals and caps, bearing brackets, valve gear parts, etc., should be cleaned free from rust and scale and coated with rust preventive coating prior to shipment. Oil tanks and gear casings should be simi-

larly treated.

After assembly of the entire turbine system it should be cleaned by circulating hot flushing oil through the lubricating system and a filter. During the initial flushing operation the bearings and governor parts should be by-passed to avoid entrance of dirt or rust into these vital portions of the system. When examination of the system and filter indicates that the tanks and lines are clean, the by-passes should be removed and the entire system flushed until inspection indicates perfect cleanliness.

After a turbine system has been properly prepared for service it should be filled with a rust and oxidation inhibited turbine grade of oil. Such an oil will prevent the metal surfaces of the system from rusting in service, even in the presence of water, by means of a protective film which the inhibitor maintains on the surfaces.

Hydraulic Equipment

Pumps, gears and interiors of hydraulic equipment should be coated either with rust preventive oil or compound at the factory after thorough cleaning. If storage or shipment is expected to be prolonged, compound should be used. In either case the hydraulic system should be thoroughly flushed out with oil before a rust inhibited grade of hydraulic oil is added for operating. This type of equipment is sometimes subject to contamination with water during operation and the selection of a special oil is necessary to avoid development of rust and subsequent difficulties caused thereby.

Machine Tools, Hand Tools, Spare Parts, etc.

The protection of all finished working surfaces of tools and parts of machinery is dependent upon (a) adequate cleaning of the surface, (b) protection with a suitable rust preventive and (c) suitable packaging.

CLEANING

Protecting finished articles with a rust preventive material and a well designed package may be a waste of effort if good cleaning procedures are not used first. There are a number of methods for cleaning finished steel surfaces which are capable of producing satisfactory results, but each case should be considered carefully before selecting the most satisfactory cleaning procedure.

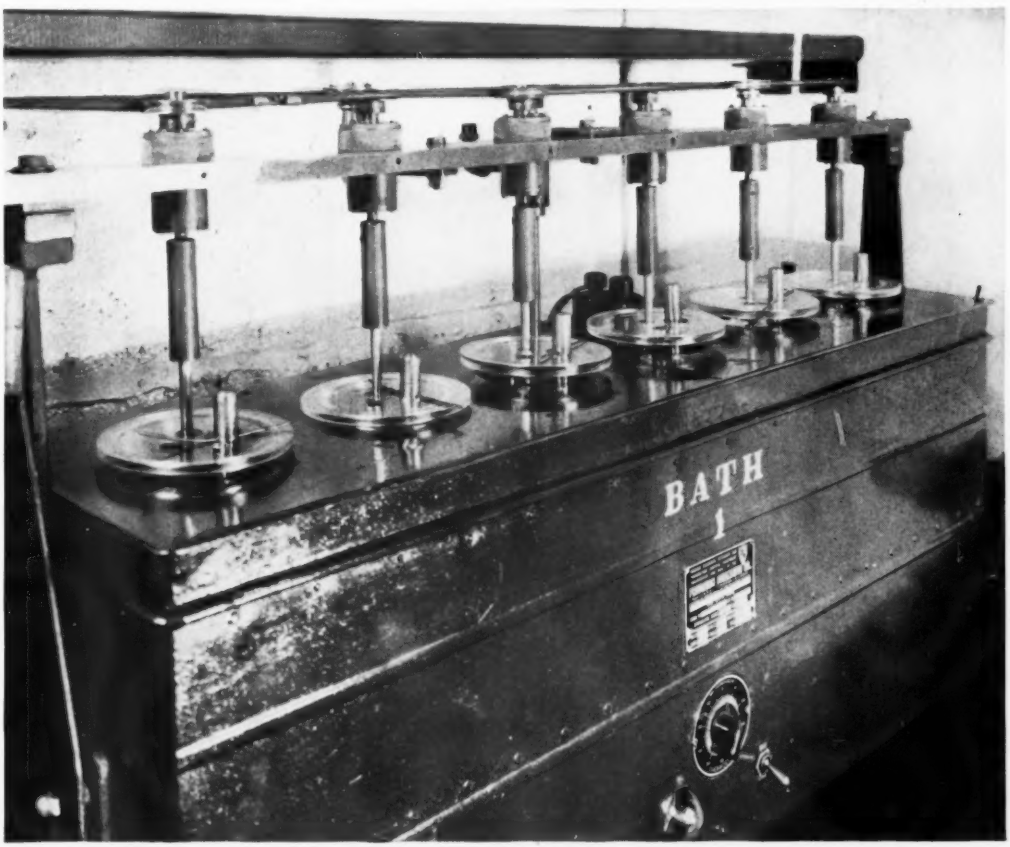


Figure 7 — Bath for conducting rusting tests on rods immersed in turbine oil in accordance with ASTM D-665-47T procedure at 140°F.

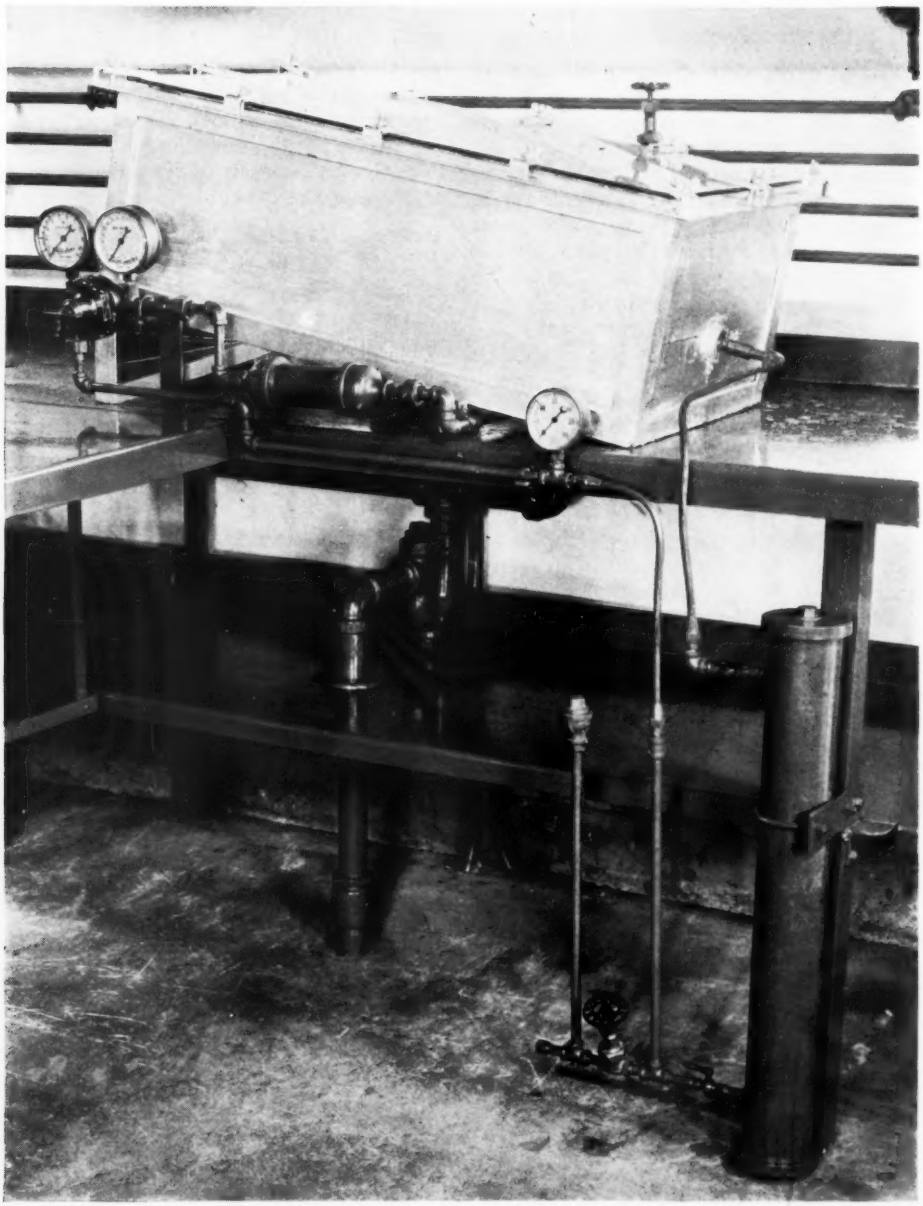


Figure 8 — Side view of a salt spray cabinet showing controls.

Most surfaces are contaminated with one or more of the following: oil, grease, dust, perspiration, cutting oil, water, salts, metallic particles and residual compounds from machining, lapping, grinding or buffing.

Liquid Solvent Cleaning

Petroleum solvents are generally most suitable for removal of oil and grease. The most suitable grade is Stoddard solvent or dry cleaner's naphtha. Gasoline containing tetraethyl lead should never be used. In case perspiration is to be removed a second solvent cleaning with methyl alcohol will be effective. Both solvents can be used by dipping, brushing or spraying.

Vapor Solvent Cleaning

Various solvents can be used for cleaning by exposing the parts to their vapors. Equipment for this procedure consists of a closed vessel containing the solvent with heating coils in the bottom, a space directly above this for suspending the parts being cleaned in the vapor and condensing equipment for reliquefying the solvent. Because of the fire hazard

involved in this procedure, non-inflammable solvents containing chlorine are frequently used. Care should be observed that corrosion does not occur, due to the action of these solvents particularly when contaminated with water. Carbon tetrachloride is particularly unsuitable due to this possibility. In all cases where a chlorinated solvent is used it should be checked frequently for presence of free acid. If acid is found it should either be neutralized before proceeding or the solvent discarded.

Alkaline Cleaning

Dilute alkaline solutions in water are effective for removing all kinds of contamination from steel surfaces. Many such cleaners are on the market but they should not be used on aluminum, zinc or magnesium which are attacked by alkali. Neither, should they be used on highly finished steel surfaces since a thin film of salt may be left on such surfaces. They are most effective when used hot at about 200° F., the parts being either sprayed or dipped. Spraying is more suitable when the contamination requires impact for removal but is not satisfactory if parts contain surfaces which cannot be reached by the spray. Alkaline cleaning should preferably be followed by cleaning in hot clear water.

DRYING

Regardless of what cleaning procedure is used all parts should be thoroughly dried either by clean dry compressed air, in an oven, or by careful wiping with clean dry lintless cloths. They should be kept at temperatures above the dew point of the atmosphere until protected with a rust preservative. They should not be touched by the hands after cleaning but should be handled with tongs or gloves since rusting is liable to occur even after coating with rust preventive material at spots where finger prints of perspiration are left.

APPLICATION OF RUST PREVENTIVE

All rust preventive materials can be applied by spraying, brushing or dipping although it may be necessary to either heat or cut back the heavy compounds with a solvent. Heating a product containing a petroleum solvent will increase the fire hazard and should be avoided. It is not necessary since the consistency can be reduced more readily if desired by the use of more solvent. When spraying is used, care should be exercised that only clean dry air is supplied to the spray nozzle.

The selection of the preservative should be based upon the degree of protection required and whether or not it is to be removed at the time the equipment is placed in service. Regardless of the inhibitors used in the manufacture of the material it is generally true that the thicker the film the better the protection. Articles which are going to be carefully packaged and stored indoors for a limited time in temperate climates can be protected adequately with a comparatively fluid oil. On the other hand equipment that is not to be completely sealed, which is liable to be exported or remain out of use for a

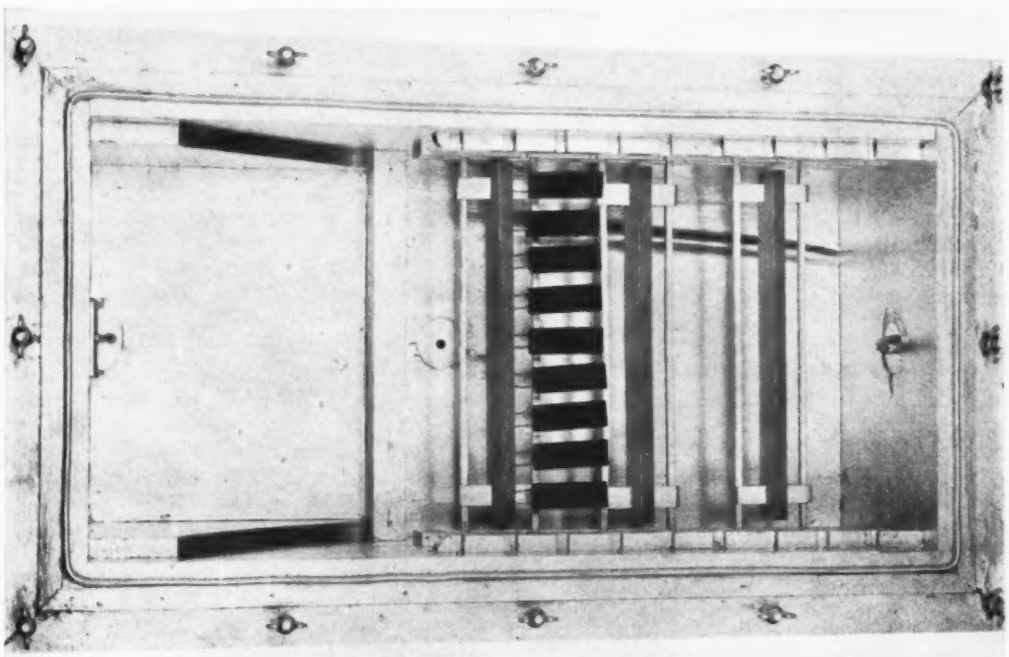
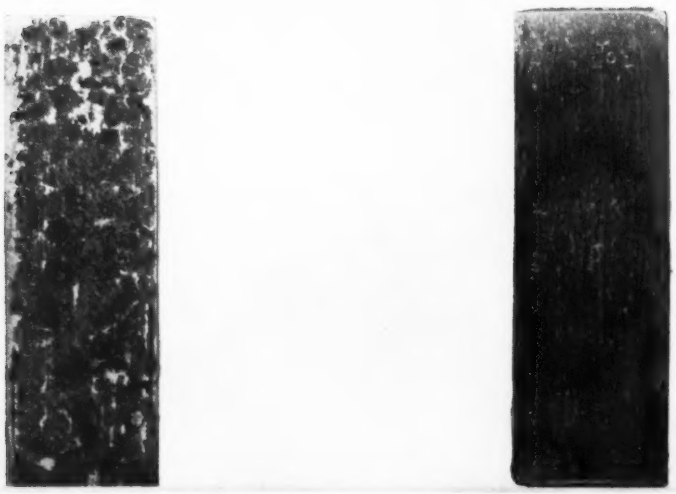


Figure 9 — Top view of a salt spray cabinet.



1 2

Figure 10 — Panels after 100 hours exposure in salt spray cabinet.
1 — Partially inhibited SAE 10 oil. 2 — Rust inhibited oil.

long time in severe climates should be well coated with a heavy rust preventive product even though it may be slightly more troublesome for someone to remove the coating when put in service. A wide range of materials and conditions obviously exists between these two examples. Hot dipping in a heavy compound will eliminate all traces of moisture from surfaces and result in long time protection particularly when the equipment is adequately packaged. The thickness of application can be controlled by varying the temperature and time of dipping.

PACKAGING

After coating parts with rust preservative materials they should be further protected from air, dirt and moisture by some sort of package if the best service from the coating is to be realized. The quality of this package should depend upon the storage conditions anticipated.

Small parts should be wrapped in greaseproof paper which will not absorb the rust preventive coating and thereby destroy its effectiveness at points of contact. Wrapping material should also be waterproof if this feature is needed. Articles having large air volume such as large bearings are preferably wrapped so as not to include this air in the package. Large equipment that is coated and wrapped should be protected from the crate so that the coating is not abraded away during handling. The use of wood containing moisture or rosin should be avoided.

In cases such as aircraft engines, large guns, etc., where the ultimate in protection is desired, a complete vapor-proof package may be justified accompanied by a dehydrating agent inside the package. Smaller valuable articles destined for prolonged storage may be completely immersed in the rust preventive material inside an oil and airtight container.

METHODS OF TESTING RUST PREVENTIVE MATERIALS

In order to select rust preventive materials intelligently it is necessary to be able to predict to some degree their probable performance from tests conducted in a relatively short time in the laboratory. In addition to the usual tests such as viscosity, flash point, volatility and consistency, a number of such accelerated performance tests have, therefore, been developed. The degree of reproducibility of these tests is none too accurate and the correlation of results therefrom with actual serviceability is difficult, due not only to the fact that the storage conditions to be encountered by one piece of equipment may be quite different from that of another but also to the fact that no actual storage conditions are likely to be the same as those used in the laboratory. Such tests are, however, definitely of value in that they are severe and accelerated and can, therefore, be used to classify products into groups of poor, better and good rust preventives when used under severe storage conditions.

Performance tests are conducted on specimens of steel that are carefully cleaned and coated under prescribed conditions with the material being tested. Indeed the preparation of the test specimen is fully as important as the test itself. Preparation of such

specimens is not necessarily the same for all tests in common use but it is very important that uniformity in all details be practiced when making comparisons between rust preventive materials or between laboratories testing the same material.

Immersion Tests in Water

The most simple test is one in which the coated piece of steel is simply immersed in either plain water or salt water. The difference between good rust preventive materials and poor ones is readily apparent by comparing the rust that develops in this test. The significance of the test, however, is not too pronounced unless the protected article is actually going to be submerged in service. It is no longer used to any great extent in specifications.

Turbine Oil Rusting Test

A method of testing oil for its ability to protect against rusting in the presence of water is in common use for turbine oils. It is also of value for hydraulic oils or any place where the oil when used as a lubricant must also prevent rusting if contaminated with water. The test can be made more severe by using salt water in the test which exposes a steel rod immersed in an agitated mixture of 10 parts oil and 1 part water at 140° F. for 48 hrs. This test simulates many service conditions and distinguishes readily between an ordinary oil and one which is sufficiently inhibited that rust free operation of a turbine can be realized. It has been standardized by the American Society for Testing Materials, under designation D 665-47T. It is of doubtful significance in evaluating an oil intended merely as a rust preventive coating for parts in storage which do not encounter this condition.

Salt Spray Test

This is an old test that has been used with considerable success for evaluating not only petroleum type rust preventive oils and compounds but paints and metallic coatings. A number of variations of the test are in use all of which are quite severe. Reproducibility between laboratories is not good but the test is valuable for comparing products in the same equipment. It is particularly significant in cases where the anticipated storage conditions include exposure near or on the sea. The test consists in exposing a coated specimen to a salt spray atmosphere in a closed box usually at 100 F. using a 4% salt solution simulating sea water. A 10% solution is also sometimes used. The results are measured in hours or days that exposure to the spray is

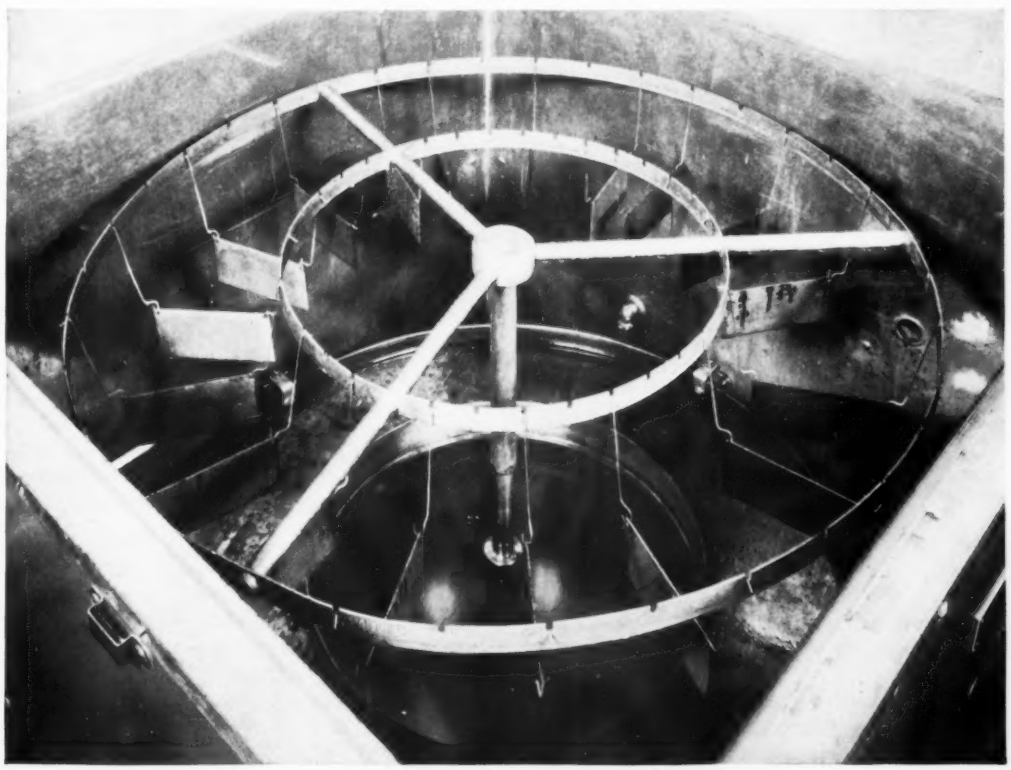
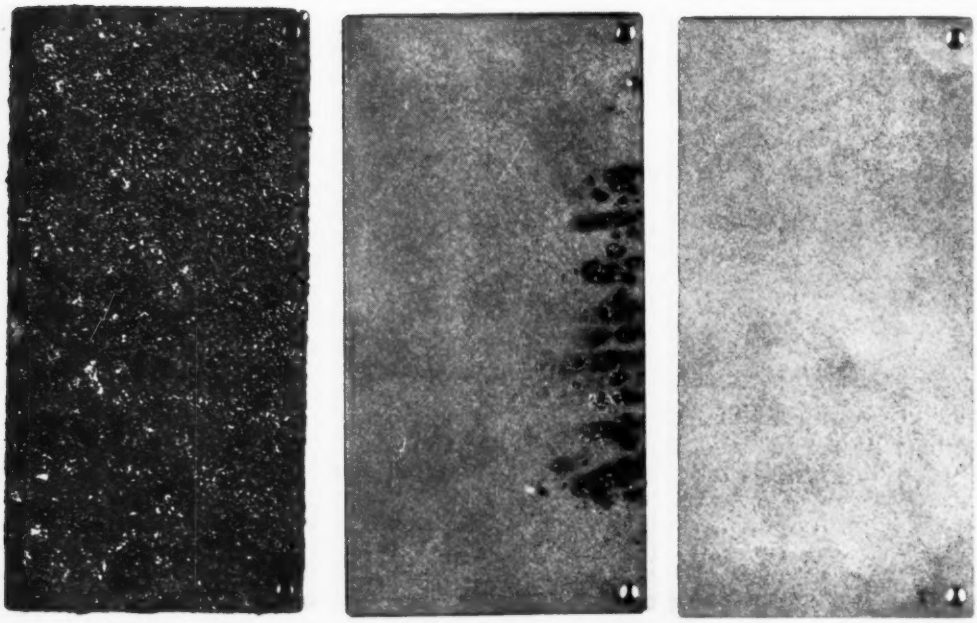


Figure 11 — Looking into a humidity cabinet with top removed.
Note varying degrees of rust on panels hung from revolving support with same panels showing no rust. This cabinet meets Army-Navy Aeronautical Specifications AN-H-31.



1 2 3

Figure 12 — Humidity cabinet test panels after 150 hours at 120°F. and 100% Relative Humidity.

1 — Ordinary airplane oil. 2 — Partially inhibited airplane oil. 3 — Aircraft engine preservative oil.

withstood without the appearance of rust on the specimen.

Humidity Cabinet Test

This test has come into popular use during the recent war and is frequently encountered in government specifications. It consists in exposing a coated panel to an atmosphere of essentially 100% relative humidity in a cabinet at either 100°F. or 120°F. Results are usually reported in hours exposure without rusting. All details of the test have been exhaustively investigated by various groups of laboratories but the reproducibility is still unfortunately very poor. The test is nevertheless valuable because it differentiates between poor and good materials under conditions which are frequently encountered in the field. A poor product will fail in this test in a relatively few hours. A good product may run from 150 hours to 800 hours yet the significance of different results between these figures is very questionable since correlation with actual protection in field storage is lacking.

Modification of this test involves exposing the panel to a carbon arc lamp to simulate sunshine before placing in the cabinet, or alternately placing a specimen in the cabinet and removing it for periods of drying. The most significant procedure has probably not yet been evolved or proved.

CONCLUSION

The design and construction of machinery for replacing human labor is one of the outstanding accomplishments of American industry. The efficient use of this machinery depends to a large degree upon preventing its deterioration during shipment, storage and use from the ever-present forces of nature which cause rusting.

The protection of equipment and spare parts during shipment and storage can be accomplished with a variety of petroleum products having excellent rust preventive characteristics. Oils and greases are available that not only lubricate but also protect against rusting during operation of machinery under adverse conditions, during intermittent shutdown periods, or during seasonal storage.

Detailed procedures for cleaning parts and applying rust preventive petroleum products have been described in this article. The use of rust preventive lubricating oils and greases are discussed and laboratory methods for evaluating the rust protective properties of such materials outlined. These methods have largely been developed in recent years. They are receiving further attention in order to improve their accuracy and establish more clearly the significance of each and its correlation with serviceability under various conditions of use.

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TEXACO RUSTPROOF MATERIALS

Texaco Rustproof Oil

A thin oil of about 40 seconds viscosity at 100°F. containing a volatile thinner which evaporates, leaving a thin highly protective film.

Texaco Home Lubricant

A rust preventive light oil having a viscosity of 100 seconds at 100°F. with good protective properties.

Texaco Cepheus Oil D

A rust preventive oil of about 300 seconds viscosity at 100°F. which leaves a relatively heavy film.

Texaco Preservative Oil

This oil comes in both SAE 10 and SAE 30 grades. It has excellent rust preventive properties and is particularly suitable for the internal protection of engines.

Texaco Regal Oils (R&O)

A complete series of highly refined rust inhibited oils intended particularly for use in steam turbines and hydraulic equipment.

Texaco Aircraft Instrument Oil

An extremely well refined light viscosity oil having a pour test below −70°F. This oil has special rust preventive properties and is recommended as a general purpose low temperature lubricant.

Texaco Rustproof Compounds

A series of relatively viscous non-hardening materials that afford excellent protection against rust even under severe and prolonged storage conditions.

Rustproof Compounds

	H	*H (Hot Dip)*	*L*	*LB*	*Spray*
Grease Penetration (Unworked @ 77°F)	140	140	260	250	Soft
Softening Point °F (Petrolatum Method)	142	142	129	130	Soft
Flash (COC) °F	440	440	135	140	100
Thinner %	0	0	24	24	50
Application	Brush	Hot Dip	Brush or Spray	Brush or Spray	Spray or Dip or Brush

GET RUST PROTECTION

This effective, simple way

TEXACO *Rustproof Compound L* or *Texaco Rustproof Compound (Spray)*, applied to exposed metal surfaces, effectively guards against rust. More than that — if rust has already started, *Texaco Rustproof Compounds* penetrate it, loosen it for easier removal, and arrest further rusting.

You simply brush *Texaco Rustproof Compound L* or spray *Texaco Rustproof Compound (Spray)* on the metal you want protected. They form a *waterproof* film, soft and self-healing against accidental scratches.

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